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Seasonal Zonation pattern of Meiobenthic Fauna of an Intertidal belt in the coastal area of Midnapore (East), West Bengal, India

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Abstract

Meiobenthos represnts one of the important coastal faunal biodiversity components by virtue of their abundance and unique distributional patterns. They play vital role in the complex food web dynamics of any marine-estuarine-coastal environment and thereby become an important subject in marine ecology research. Present study was initiated at one intertidal belt alongside the coast of Midnapore(East) district, West Bengal, India in order to record the seasonal dynamics of meiobenthic fauna along with cross-shore and depth gradients. The study has revealed that nematodes shared major proportion of meiobenthic faunal components followed by protozoan ciliophora. Temperature, salinity and the texture of the soil have been found to play a key role in determining both horizontal and vertical distribution of meiobenthic fauna. High tide level zone tended to harbour maximum number of meiobenthic fauna than the low tide level. Highest density and diversity of meiobenthic assemblages as documented in the surface layer was supposed to be due to the exposure of different nutritional sources and other physical factors especially tidal exposure and innundation which are required for the growth and survival of the biotic components. The upper part of the intertidal zone has appeared to be the most effective zone to study the community interactions among meiofauna.

Keywords: Meiobenthos, high tide level, seasonal dynamics, nematodes.

Introduction

Coastal zone provides a unique productive and diverse ecosystem necessary for human habitat establishment and successive development. More than 50% of the world's human settlement happens within the 60 km. of the coastline, and 75% of this rise could be evident by the year 2020[1]. The anthropogenic pressure along the narrow coastal tract is escalating day-by-day surrounding the world's ocean, which are principally dominated by sandy beaches. Therefore globally sandy beaches are more prone to heavy exploitation in near future[2]. Scientific accounts on the benthos of the Indian subcontinent initiated with Annandale[3]. Different ecological works were done on meiofaunal composition as well as free-living marine nematodes from India. Literatures on meiobenthic fauna of northern-east coast of India are very scanty. The study on meiofauna was done by Rao and Misra[4] in Sagar Island, West-bengal, India. The study on meiobenthos and macrobenthos of Digha beach was undertaken by Rao and Misra[5], around three decades back. No such data on population dynamics of meiobenthic organism are still available from West Bengal coast. Meiobenthic fauna especially free-living marine nematodes are one the most important components of the benthic communities and their role in trophic food webs is crucial[6]. Thus the Directives of European Water Framework proposed the phylum, nematoda as an indicator for the assessment of quality of marine ecosystems[7]. The present paper has attempted to study seasonal dynamics of meiobenthic faunal communities at Digha mohana, the fish landing centre of Midinapur (East) District, West Bengal.

Material and Methods

Study area: As per Coastal Zone Regulation Act 1991, Digha Mohana in the Midnapore (East) coast and the adjacent developed areas are located very near to coastal zone which is designated as CRZ-II. The southern region of the coast is elevated less than 3m. above the sea level[8, 9]. The beach material is generally made up with silica, clay and quartz with medium to fine shorted sand particles. Deposition of irregular estuarine mud along many places of the coast mixes with the sandy beach and forms mixed flats. The water is turbid due to constant mixing of mud carried to the offshore by the water system itself[10].

The range of tidal amplitudes of Digha-Junput coastal tract within Midnapore (East) usually fluctuates between 4m. and 2m. in the spring tide and neap tide respectively[11]. Waste disposal, oils and other related organic products from the fishing harbours after being discharged from different trawlers, tankers, ships and vessels contribute pollutants into the nearby estuaries[12]. This pollution causes mortality of diverse marine lives.

The geomorphology around Digha coastal area has changed dramatically within last three decades with an increased anthropogenic pressure. In the present day, over 4 million tourists visit Digha and surrounding areas every year[13].

Collection, Preservation and Data analysis: Sediment samples were collected from the intertidal regions of Digha Mohana, East Midnapore, West Bengal (21° 37.84′ N and 87° 32.83′ E; figure-1) with the help of a hand corer from April, 2012 to February, 2013 to cover the three main seasons viz. premonsoon (March–June), monsoon (July–October) and postmonsoon (November–February). Collections were done from three intertidal station viz. High Tide Level (LTL) or High Water Level, Mid Tide Level (LTL) or Mid Water Level and Low Tide Level (LTL) or Low Water Level[14]. Two replicates of the each sample were collected each time. Each 15 cm. column core was then separated into three equal divisions of height of 5 cm., viz. upper, middle and lower layer.

Temperature, salinity and pH of the habitat water were collected on the spot. Sediments were analysed after sun drying. Meiofaunal samples were treated with 5% formalin and left for overnight. Then samples were sieved with two brass sieves, upper one of 5oo µm mesh and lower one of 63 µm mesh size. Those retained on the sieve of 63 µm mesh width are considered as meiofauna[15]. The sieved samples were preserved in 5% neutral formalin solution in wide mouth plastic vials. Meiofauna taxa were separated with the help of compound microscope. Meiofaunal densities were calculated for 10 cm^2.

Results and Discussion

Environmental determinants: Sea water temperature was recorded as highest during premonsoon (37.7°C) and that of lowest during postmonsoon (24.6°C). Salinity was highest during premonsoon (27.8 ppt) but lowest during monsoon (9.1 ppt). pH was recorded high during premonsoon (8.66) and was found to be low during monsoon (7.17). Being a sandy intertidal area, sand contents were recorded highest at HTL but LTL contained highest clay content throughout the year (figures-2 to 5).

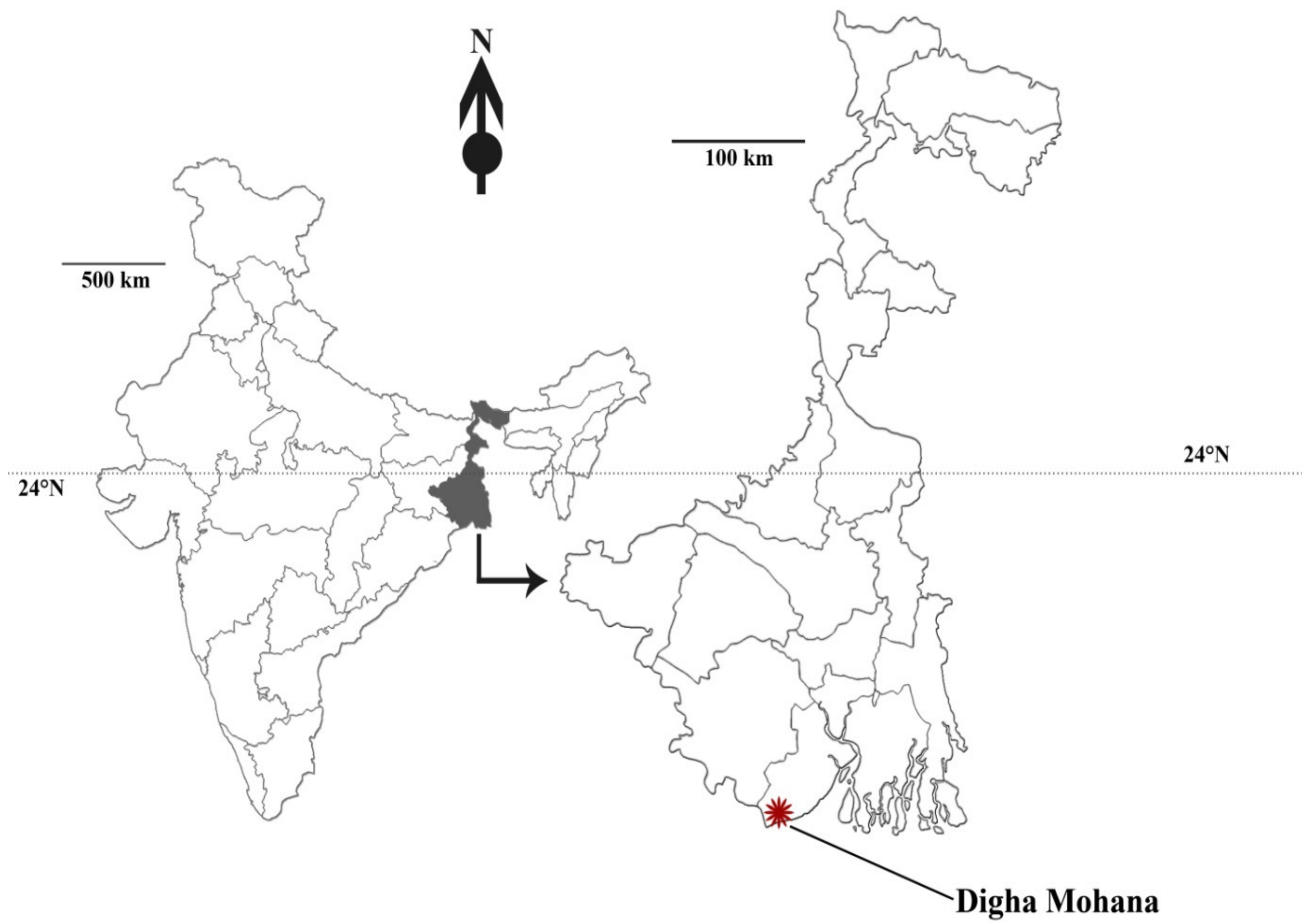

Figure-1
Study site

Meiofuanal density and Distribution: Seasonal, Cross-shore and Vertical profile: Nematoda, ciliophora, gastrotricha, nemertea, polychaeta, and Foraminifera are the major groups those have been found during the survey. Molluscs, oligochaets, halacarid mites, turbellarians,and some larval forms are listed as others.

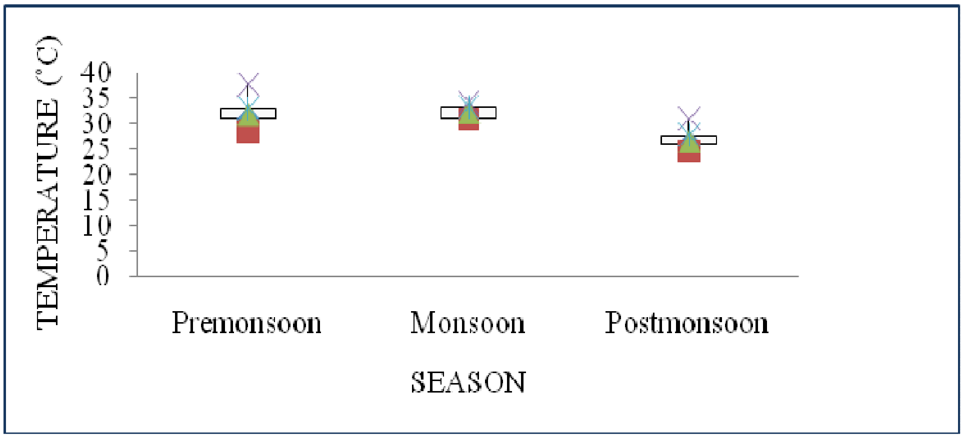

Figure-2
Seasonal changes of sea-water temperature

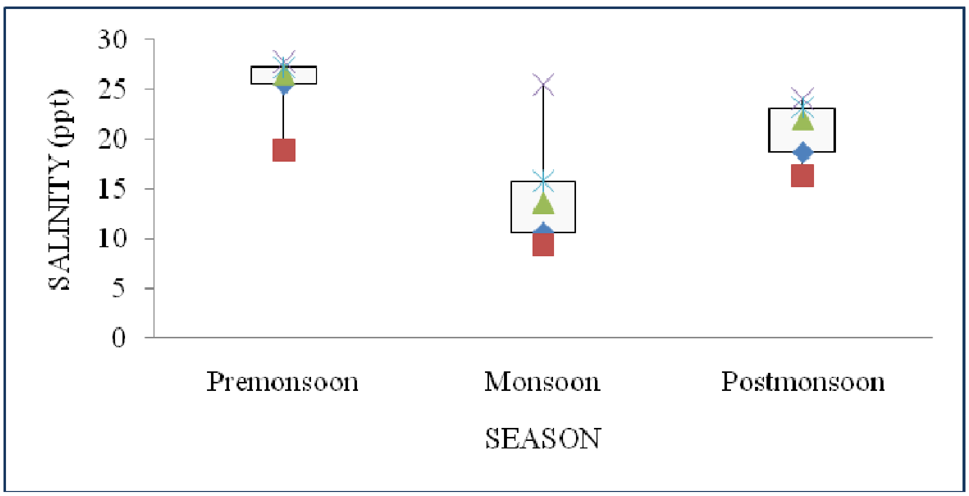

Figure-3
Seasonal changes of sea-water Salinity

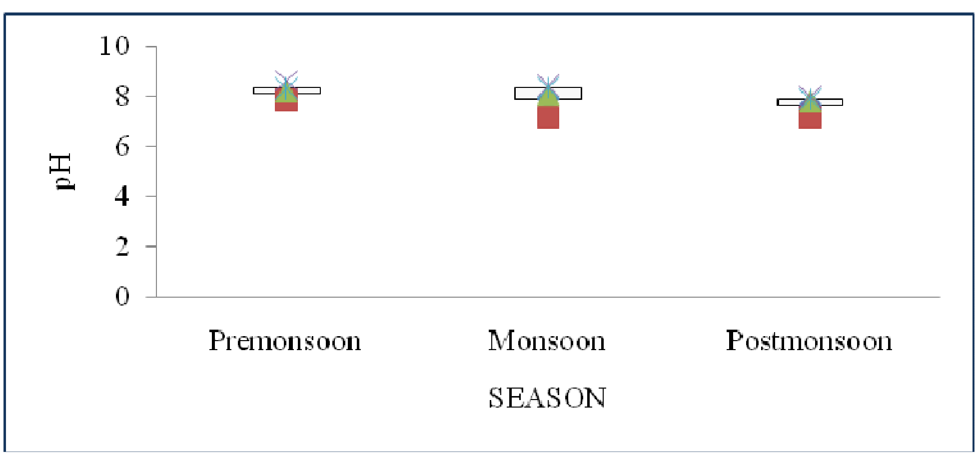

Figure-4
Seasonal changes of sea-water pH

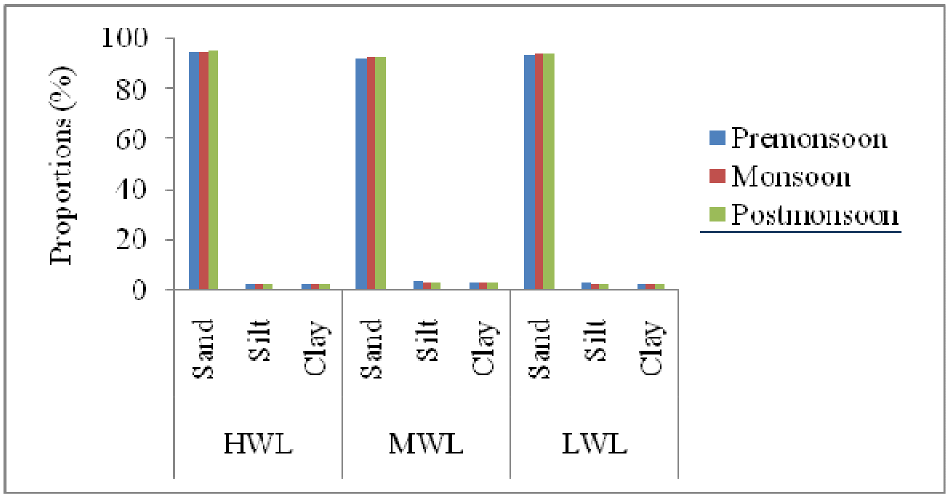

Figure-5
Seasonal changes of intertidal sediments with cross-shore variance

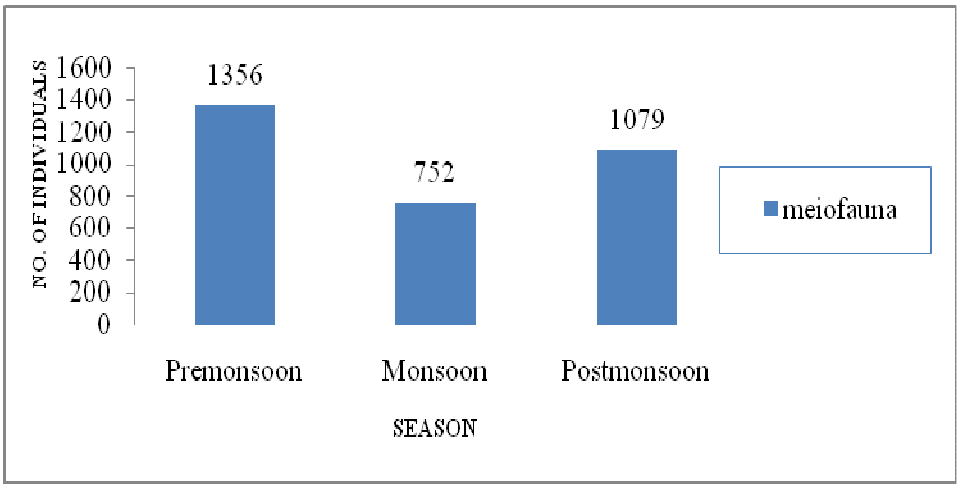

Figure-6
Seasonal changes of meiobenthic composition (average)

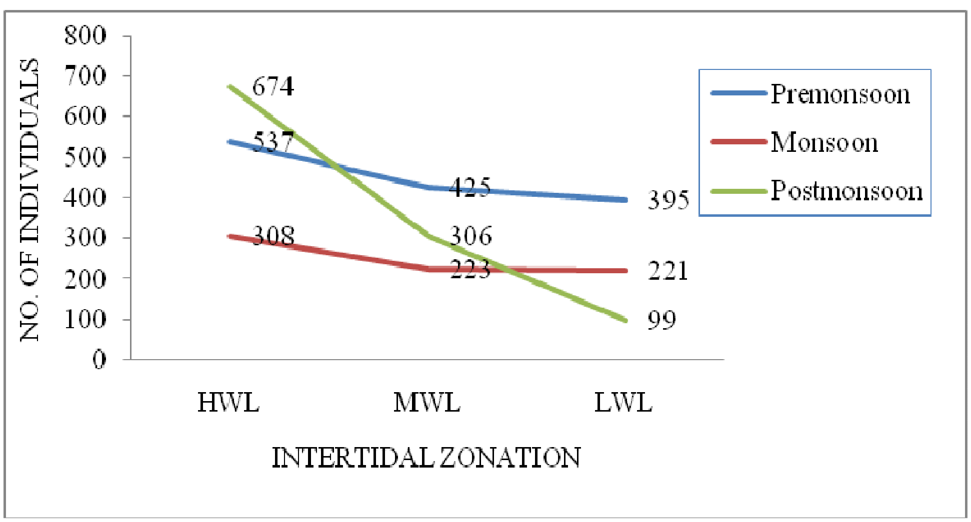

Figure-7
Cross-shore distribution of meiofaunal communities in different seasons

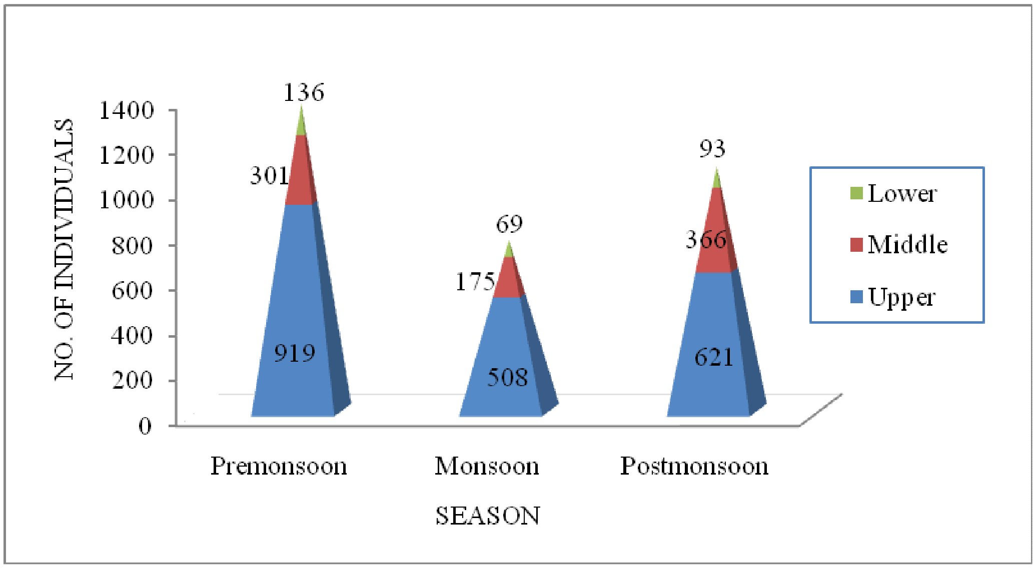

Figure-8
Vertical distributional profile of meiofaunal communities in different seasons

Highest number of meiobenthic assemblages was observed during premonsoon s and diversity decreased during monsoon (figure-6). Cross shore distributional pattern have revealed that highest number of meiobenthic fauna were aggregated at HTL and number of meiobenthic faunal components tended to decrease from MTL to LTL (figure-7). It was observed that upper layer of sediment always carried highest number of meiobenthic communities while bottom layer harboured less number throughout the season (figure-8).

Table-1
Meiofaunal distribution during Premonsoon Season

Taxa	Upper Layer (U) (Mean ± Stdev)	Middle Layer (M) (Mean ± Stdev)	Lower Layer (L) (Mean ± Stdev)
Nematoda	316.8±83.1	141.7±19.4	71.9±14.1
Ciliophora	44.3±15.5	13.9±2.9	2.3±1.2
Gastrotricha	505.4±241.9	128.4±67.9	56.1±52.7
Nemertea	37.9±12.9	9.7±2.9	1.7±1.2
Ostracoda	2.8±0.5	0.9±0.3	0.1±0.1
Copepoda	3.0±0.8	0.3±0.4	0.1±0.2
Polychaeta	1.0±0.2	0.7±1.0	0.2±0.3
Foraminifera	1.8±1.2	0.8±0.9	0.2±0.1
Others	6.2±0.5	4.5±0.3	3.2±0.7

Table-2
Meiofaunal distribution during Monsoon Season

Taxa	Upper Layer (U) (Mean ± Stdev)	Middle Layer (M) (Mean ± Stdev)	Lower Layer (L) (Mean ± Stdev)
Nematoda	333.1±88.5	128.9±32.2	57.6±8.7
Ciliophora	90.0±7.4	16.0±10.2	2.5±3.3
Gastrotricha	4.9±5.3	2.4±4.1	0.0±0.0
Nemertea	24.8±11.4	11.8±4.5	1.4±1.5
Ostracoda	6.5±5.0	1.3±2.3	0.0±0.0
Copepoda	1.2±1.2	0.0±0.0	0.0±0.0
Polychaeta	12.3±7.5	7.2±6.3	3.5±6.1
Foraminifera	28.4±13.8	0.7±0.6	0.0±0.0
Others	6.5±4.2	6.3±2.7	4.3±0.7

Nematode comprises more than half (60.7%) of the population throughout the year. Nematode families viz. oncholaimidae, thoracostomopsidae, xyalidae, ironidae, hypodontolaimidae, tripyloididae, desmodoridae etc, were the abundant. gastritrcha (23.3%) was the second most abundant taxa. Third most abundant taxa was ciliophora (6.6%) among the major groups. Nematodes were encountered 25%–88% among the total meiofaunal communities in different seasons and sites. At the upper sediment layer the abundance of nematodes found dominating in number during postmonsoon (507.3±414.3/10 cm^2) and monsoon (333.1±88.5/10 cm^2) while premonsoon was dominated by gastrotricha (505.4±241.9/10 cm^2). With depth Nematodes were encountered as the most abundant taxa throughout the season. Among the prozoan taxa, ciliphora was recored in higher abundance followed by heard shelled foraminifera. Ciliophoran were found high in number during monsoon while were encountered in less numbers during postmonsoon. Foraminiferan was recorded in higher numbers during monsoon. Highest number of ostracods were found during postmonsoon. Depth wise distribution of different meiofaunal taxa in three seasons are presented in table-1 to 3.

Table-3
Meiofaunal distribution during Postmonsoon Season

Taxa	Upper Layer (U) (Mean ± Stdev)	Middle Layer (M) (Mean ± Stdev)	Lower Layer (L) (Mean ± Stdev)
Nematoda	507.3±414.3	307.2±317.6	71.2±71.8
Ciliophora	27.2±24.3	10.8±18.8	1.8±3.2
Gastrotricha	31.0±18.9	14.5±13.0	1.2±2.0
Nemertea	12.5±6.5	5.7±2.3	0.7±1.2
Ostracoda	8.2±0.6	4.0±0.5	0.5±0.5
Copepoda	1.2±2.0	1.3±1.5	0.0±0.0
Polychaeta	0.0±0.0	0.0±0.0	0.0±0.0
Foraminifera	10.3±4.0	4.2±0.6	1.8±1.6
Others	22.8±0.6	18.5±1.0	15.3±2.9

As Nematodes were found as most abundant taxa in the meiofaunal communities, interaction of nematodes within the communities were tested to reveal the success in competition in between meiofauna (figure-9 to 11).

Conclusion

Temperature and salinity have already been considered as major environmental parameters controlling marine invertebrates[16, 17]. Higher salinity helps the marine organisms to reproduce as well as attaining maturity. Highest clay deposition was found at the mid water level and high sand content at the High Tide Level. Upper layer always contains higher proportion of sand. Therefore, more interstitial spaces are there which accommodates more oxygen. That's why at the depth gradient higher meiofaunal densities are occurred at the top layers. Large abundance of meiofaunal communities during premonsoon suggests the salinity is the major determinant. From the above observation, this can easily be predicted that Nematodes are one of the most abundant taxa among meiobenthic communities at the study sites. The competitive strategies of nematodes are also found that their abundance depend upon the availability of other meiofaunal groups as great predatorial activity is already been seen in meiobenthic communities. Higher number of nematofaunal assemblage is related with less completion among meiobenthic fauna. Organisms show sharp decrease in number according to depth variation. Higher shore contains the highest number of meiofaunal assemblages and lower part harbours less in number. Therefore a clear adaptive zonation pattern of these interstitial fauna along the intertidal area is found throughout the seasons. The zonation pattern of studied meiobenthic fauna has displayed a contrasting result with the zonation of larger intertidal brachyuran crab of the similar environment[14]. Meiofauna is considered as good indicator of environment because of their smaller size and short generation time. As these benthic communities are directly connected with the surroundings they can integrate the effect of different environmental stresses, significantly the marine pollutants created by anthropogenic activity. Because of that they are monitored widely to evaluate marine health. Large abundance and great adaptive strategies to a wide range of habitats suggest that nematodes play key role in the benthic ecosystem.

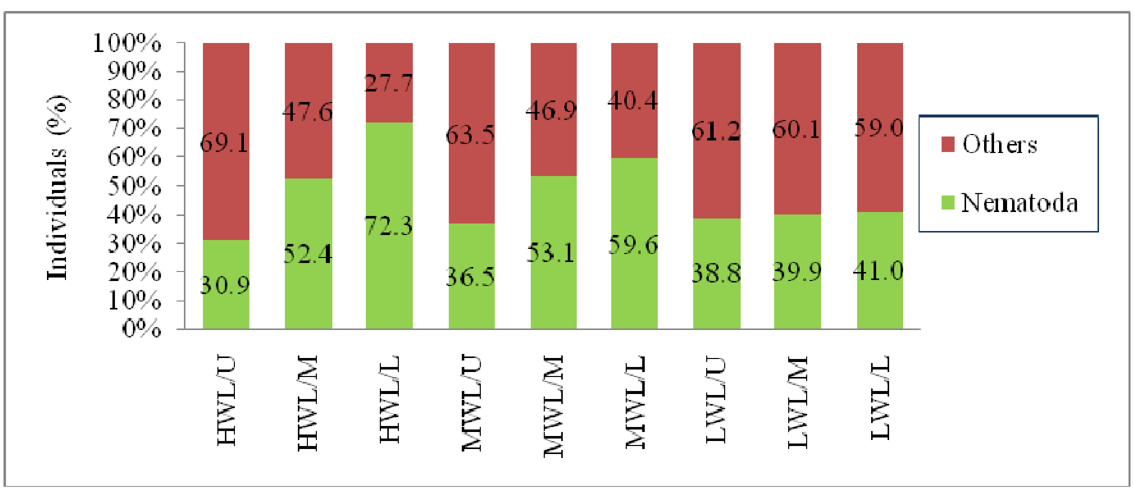

Figure-9
Abundance of free-living marine Nematodes with other meiofaunal composition at Premonsoon season

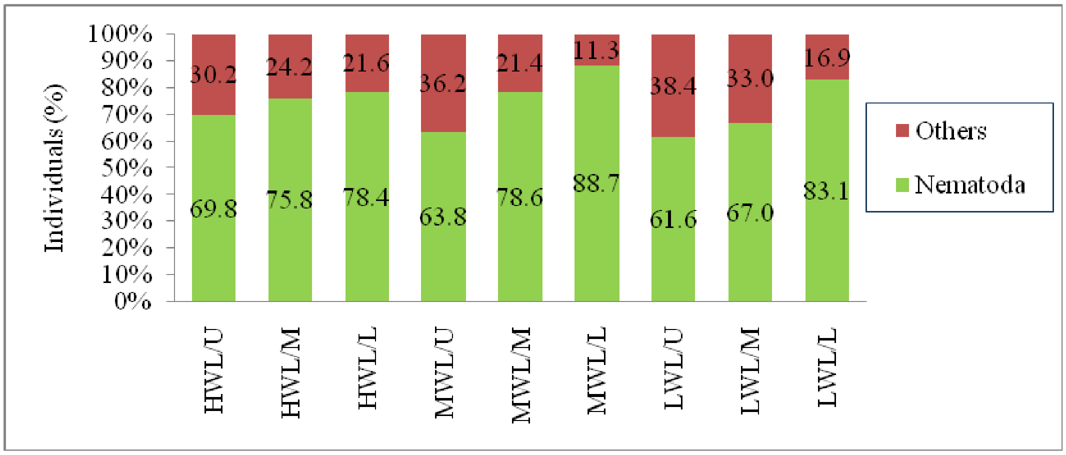

Figure-10
Abundance of free-living marine Nematodes with other meiofaunal biotic components during Monsoon season

Figure-11
Abundance of free-living marine Nematodes with other meiofaunal biotic components during Postmonsoon season

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